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## (54) Automatic analytical method using chemical analytical slides.

(57) An analytical method using chemical analytical slides comprising, placing liquid samples in an automatic sampler of an analyzer, loading in said analyzer the chemical analytical slides combined in the group according to respective analytes to be measured in each sample and a partition plate interposed between said groups of the chemical analytical slides, and changing over the sample to be spotted on the chemical analytical slide by means of said automatic sampler when said partition plate is detected.

By employing this method, the sample to be spotted can exactly be changed, and therefore, it is prevented that the serious error that the analytical result of a different person is used for diagnosis of disease and the like. Moreover, the analytical operation is simple, and working efficiency is high.

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# ANALYTICAL METHOD USING CHEMICAL ANALYTICAL SLIDES

## BACKGROUND OF THE INVENTION

### Field of the Invention

This invention relates to an analytical method using chemical analytical slides used for the determination of various components in a body fluid such as blood or urine.

### Description of the Prior Art

Recently, in clinical assay field, the advantages of dry analysis in simplicity and rapidity have been appreciated, and this method has widely been utilized. In the dry analysis, a liquid sample such as blood is spotted on a chemical analytical slide containing the reagents reacting the the object component such as glucose or urea nitrogen of the sample to produce color change such as coloring or discoloring, and the content of the object component is colorimetrically determined.

The dry analysis is usually carried out by using an automatic analyzer in order to secure accurate measurement and simplicity. In the analyzer, usually chemical analytical slides are arranged in a cartridge, and the cartridge is loaded in the cartridge loading part. The loaded chemical analytical slides are intermittently delivered one by one to the spotting part, and a liquid sample is spotted on each chemical analytical slide by a pipette. The slide is then transferred to an incubator, and warmed therein to proceed coloring reaction, Then, the color produced in each chemical analytical slide is optically measured at the photometric part to determine respective analytical subjects.

Meanwhile, there are various chemical analytical slides such as for determining glucose, urea nitrogen, hemoglobin and uric acid. Since several components of a sample are analyzed usually at once, various chemical analytical slides are combined for each sample according to its analytical items, and stacked in a prescribed order. For example, when glucose and urea nitrogen in sample I and glucose, urea nitrogen and total protein in sample II were measured, respective chemical analytical slides were arranged in the cartridge in the order of chemical analytical slide for glucose, the slide for urea nitrogen, the slide for glucose, the slide for urea nitrogen and the slide for total protein from the bottom. The changing of the sample were carried out by the worker handling the sample when the worker judged the new group of slides coming by visual observation.

In such a method, however, the changing of the samples were done in error to result in a serious problem that the analytical result of a different person was used for diagnosis of disease and the like. Moreover, since the worker had to judge respective chemical analytical slides one by one by visual observation before spotting of the next sample, the works were complicated and its efficiency was low.

## SUMMARY OF THE INVENTION

An object of the invention is to provide a method using for analysis of liquid samples chemical analytical slides for detecting various components in the liquid samples, capable of conducting the change of liquid samples exactly.

Another object of the invention is to provide an analytical method using chemical analytical slides of which analytical operation is simple and working efficiency is high.

The above objects of the present invention have been achieved by interposing a partition plate between the chemical analytical slide groups for respective samples, and changing over the samples to be spotted by an automatic liquid sampler based upon the detection of this partition plate.

Thus, the analytical method using chemical analytical slides of the invention comprising, placing liquid samples in an automatic samples of an analyzer, loading the chemical analytical slides combined in the group according to respective measuring items analytes to be determined of each sample together with a partition plate interposed between said group and another group of the chemical analytical slides in the analyzer, and changing over the sample to be spotted on the chemical analytical slide by means of said automatic liquid sampler when said partition plate is detected.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a chemical analytical apparatus used for conducting the analytical method of the invention using chemical analytical slides.

Figure 2 is a block diagram of tray-driving circuit.

Figure 3 is a perspective view indicating the stacked state of chemical analytical slides used for the method of the invention.

Figure 4 is an enlarged perspective view of the tray part of the automatic sampler illustrated in Figure 1.

Figures 5 to 7 are plan views of various partition plates used in the method of the invention.

Figure 8 is a sectional view of the chemical analytical apparatus.

## DETAILED DESCRIPTION OF THE INVENTION

The partition plate may be made of paper such as cardboard or carton, plastic, metal, wooden board, glass or the like. The partition plate may have a size and a thickness capable of delivery into the analyzer using chemical analytical slides. For smooth delivery, it has preferably a similar figure to the chemical analytical slide and the same size as or slightly smaller than the slide. The partition plate should be discriminable optically from the chemical analytical slide. For example, an identification mark such as a bar code different from the bar code of the chemical analytical slide is provided on the surface of the partition plate, and each partition plate is detected by reading the bar code optically. The bar code of the partition plate may be one kind, and it is used only for changing over the sample to be spotted. While, each bar code may be different, and the sample is identified by the partition plate. Besides, square code such as shown in FIGURE 2 of Japanese Patent KOKAI 59-125162 may also be utilized. As the changing over means of samples, either of a sampling pipette or the same placed on a rotary tray may be moved. Moreover, the receiver of sample may also be provided with an identification mark same as that of the partition plate. In this arrangement, and when the partition plate having an identification mark is detected, the receiver having the same identification mark is selected for spotting.

Examples of the sample suitable for the analytical method of the invention are whole blood, blood plasma, blood serum, urine, cerebrospinal fluid and the like, and the components to be measured include glucose, urea nitrogen, hemoglobin, ammonia, uric acid, total bilirubin, total protein, total cholesterol, calcium and the like.

## EXAMPLES

The chemical analytical apparatus 1 used for conducting the method of the invention is composed of an analyzer 2 and an automatic sampler 3, as shown in Figure 1. The analyzer 2 is provided with a cartridge loading part 7 loaded with the cartridge 6 containing chemical analytical slides 4 and partition plates 5 arranged in a prescribed order and a spotting station 8 to spot a sample on the chemical analytical slide delivered from the cartridge loading part 7. As shown in Figure 8, a photoelectric read means 14 to read the bar code of the chemical analytical slide and the identification mark of the partition plate is provided in the passage from the cartridge loading part 7 to the spotting station 8. 18 denotes slide delivery means. The analyzer 2 is also provided with an incubator (not illustrated) for incubating the chemical analytical slide and a photometric part (not illustrated) for measuring the coloration in the chemical analytical slide in its inside.

A circular tray 9 is rotatably provided on the front upper face of the automatic sampler 3. The tray 9 is provided with circular holes at a regular intervals in its circumferential direction near the margin, and each cup 10 for receiving sample is hung by engaging the flange of the cup with the edge of the hole, as shown in Figure 4. The automatic sampler is also provided with a pipette 11 for spotting sample near the tray 9. The pipette 11 capable of rotating reciprocally between the cup 10 and the spotting part 8.

The photoelectric read means 14 is, as shown in Figure 2, connected to a tray-driving part 17 through a bar code decoder 15 and a control part 16. The identification mark of the partition plate is detected by the photoelectric read means 14. The signal from the read means 14 is judged by the bar code decoder, and the result is inputted into the control part 16. The signal from the bar code decoder 15 is recognized by the

control part 16, and in the case of the partition plate, it orders the tray-driving part 17 to drive and the tray 9 is forced to rotate the angle necessary to replace the cup 10 with the next one.

By using the above chemical analytical apparatus, the following components of various samples are measured as follows:

| Sample | Cup | Measuring Item (Analyte) |
|---|---|---|
| A | A | Glucose (GLU), Urea Nitrogen (BUN) |
| B | B | GLU, BUN, Total Protein (TP) |
| C | C | GLU, Total Bilirubin (TBIL), Ammonia ($NH_3$), TP |
| D | D | Hemoglobin (HB), Uric Acid (UA), Total Cholesterol (TCHO) |
| E | E | Calcium (CA), GLU, BUN |

Chemical analytical slides above are loaded in the cartridge according to the measuring order of the samples. That is, as shown in Figure 3, the chemical analytical slide for glucose (4 (GLU)) and the chemical analytical slide for urea nitrogen (4 (BUN)) being the measuring items of Sample A are stacked in the cartridge, and then a partition plate 5 is further stacked thereon. The chemical analytical slide groups (4 (GLU), 4 (BUN), 4 (TP)) of Sample B are stacked on the above partition plate 5 successively, and a partition plate 5 is stacked on it. The stackings of the chemical analytical slides 4 and partition plate 5 are repeated to complete the arrangement shown in Figure 3.

As shown in Figure 3, a bar code 13, different according to the measuring item, is printed on each chemical analytical slide 4. While, the surface of the partition plate 5 is, as shown in Figure 5, made white and printed with no opaque bar, this being the identification mark 12.

On the other hand, as shown in Figure 3, each sample is put into a cup 10, and respective cups are set in the holes of the tray 9 in the prescribed order.

After the chemical analytical slide is set in the above mentioned state, the chemical analytical apparatus is started. The first chemical analytical slide 4 (GLU) of Sample A is delivered to the spotting station 8, where a prescribed amount of Sample A is spotted on it by the pipette 11. On the passage from the cartridge loading part 7 to the spotting station 8, the bar code 13 printed on the chemical slide is detected by means of the read means 14. This chemical analytical slide is transferred to the incubator, and warmed therein to proceed coloring reaction. Then, the color produced is measured at the photometric part. After the second chemical analytical slide 4 (BUN) is treated similarly, the partition plate 5 is delivered to the spotting station 8. At this time, since the surface of the partition plate 5 passing under the read means 14 is white without opaque bar, the signal outputted from the read means 14 is judged as the signal indicating the partition plate 5 by means of the bar code decoder 15. The result is outputted from the bar code decoder 15 to the control part 16, and the control part 16 orders the tray-driving part 17 to drive and forces the tray 9 to rotate the angle to change the cup 10 with the new cup 10 for receiving Sample B. Then, the delivery of the chemical analytical slide 4 and spotting are repeated. When the next partition plate 5 comes, the tray 9 rotates again and the next cup 10 for receiving Sample C comes just under the pipette 11 at the spotting station 8. These actions are repeated, and the measurements of all items of all samples finish.

Another example of partition plate 5 is illustrated in Figure 6. The identification mark 12 composed of relatively thick two bars is printed on the partition plate 5.

Another example of partition plate 5 is illustrated in Figure 7. The bar code of same kind as that used for chemical analytical slide is printed on the partition plate 5 as the identification mark 12, and the same bar code is also printed on a cup 10 set on the tray 9. The read means 14 reads the bar code of this partition plate 5, and the cup 10 having the same bar code is located just under the pipette 11 by the order

of the control part 16. In this example, the order of the cups 10 set on the tray 9 is not necessary to consistent with the order of the chemical analytical slides 4 stacked in the cartridge 6.

## Claims

1. An analytical method using chemical analytical slides comprising, placing liquid samples in an automatic sampler of an analyzer, loading in said analyzer the chemical analytical slides combined in the group according to respective analytes to be measured in each sample and a partition plate interposed between said groups of the chemical analytical slides, and changing over the sample to be spotted on the chemical analytical slide by means of said automatic sampler when said partition plate is detected.

2. The analytical method of claim 1 wherein said partition plate is provided with an identification mark.

3. The analytical method of claim 2 wherein the surface of said partition plate is white without opaque bar.

4. The analytical method of claim 2 wherein said identification mark is a bar code, and the same bar code is provided on the container of the sample to be spotted on the chemical analytical slides interposed between the partition plate having said identification mark and the next coming partition plate.

FIG. 1

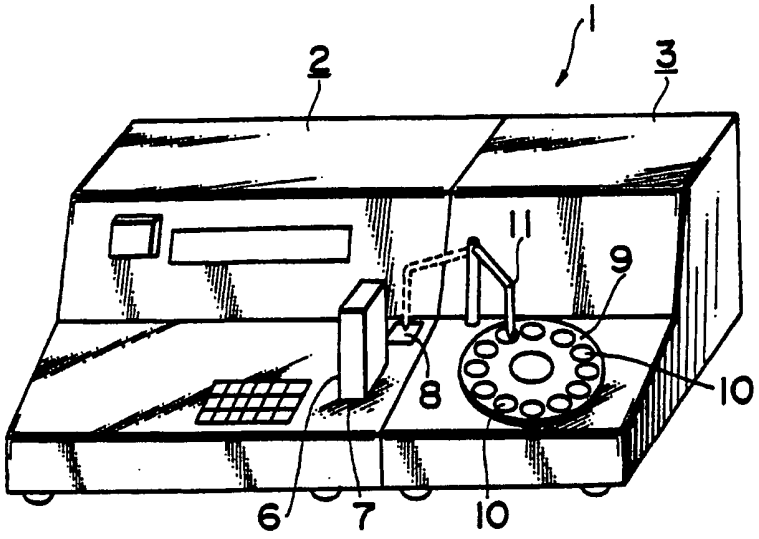
1
2
3
11
9
10
8
6
7
10

FIG. 2

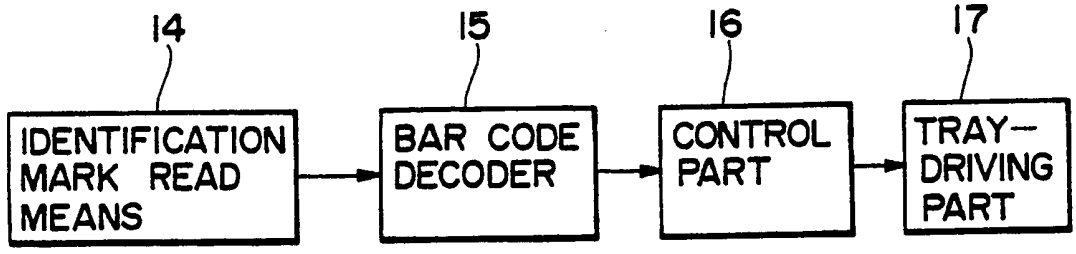
14
15
16
17
IDENTIFICATION MARK READ MEANS
BAR CODE DECODER
CONTROL PART
TRAY-DRIVING PART

FIG. 3

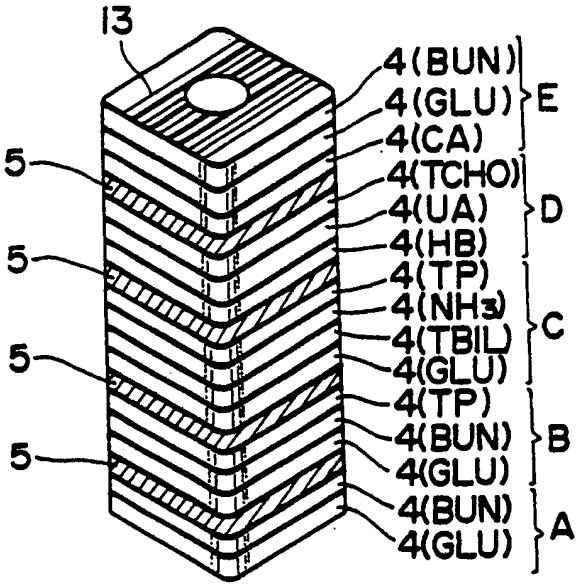
13
5
5
5
5
4(BUN)
4(GLU)
4(CA)
4(TCHO)
4(UA)
4(HB)
4(TP)
4(NH3)
4(TBIL)
4(GLU)
4(TP)
4(BUN)
4(GLU)
4(BUN)
4(GLU)
E
D
C
B
A

FIG. 4

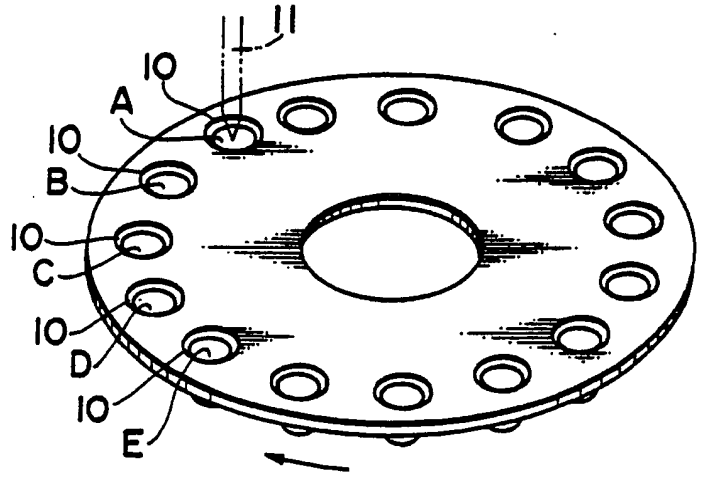
11
10
A
10
B
10
C
10
D
10
E

FIG. 5

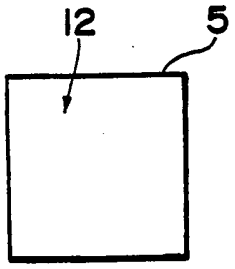


FIG. 6

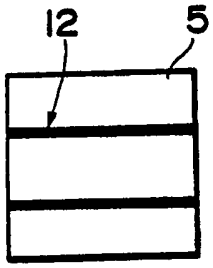


FIG. 7

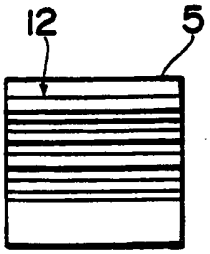
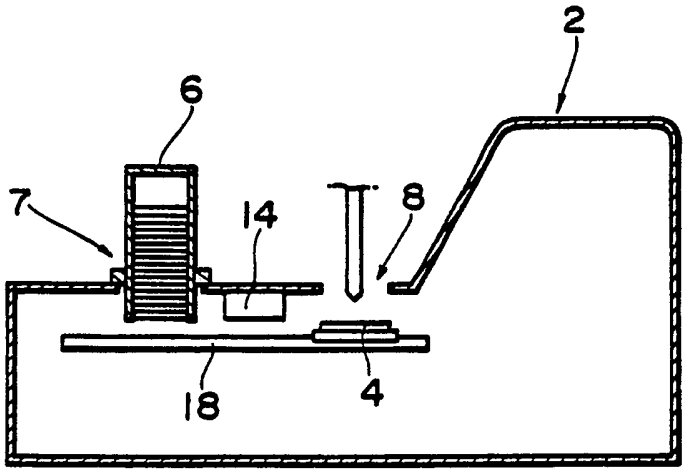
FIG. 8